

# Benchmarking for Maintenance Operations

Jennifer Brandenburg, PE  
State Road Maintenance Engineer

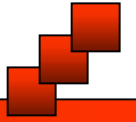


# What Is Benchmarking?



- Process of measuring condition and comparing it to customer expectations
- Looks at best practices and most effective ways to spend highway funds
- Continuous quality improvement
- Measures outcomes instead of processes

# Why Benchmark?



- Learn from past successes, minimizing trial and error
- Improves customer satisfaction and the condition of highway system
- Reduces life cycle costs
- Able to deal more effectively with legislature and public
- Better able to allocate resources to most needed work
- Improves morale and job performance of employees

# Who Are Our Customers?



- Legislature
- Public
- Divisions
- Central Units

# Benchmarking Outcomes



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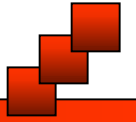
- Total Asset Management
- Performance Based Standards
- Needs Based Funding



- Pavement Condition Survey
- Bridge Condition Survey
- Maintenance Condition Survey

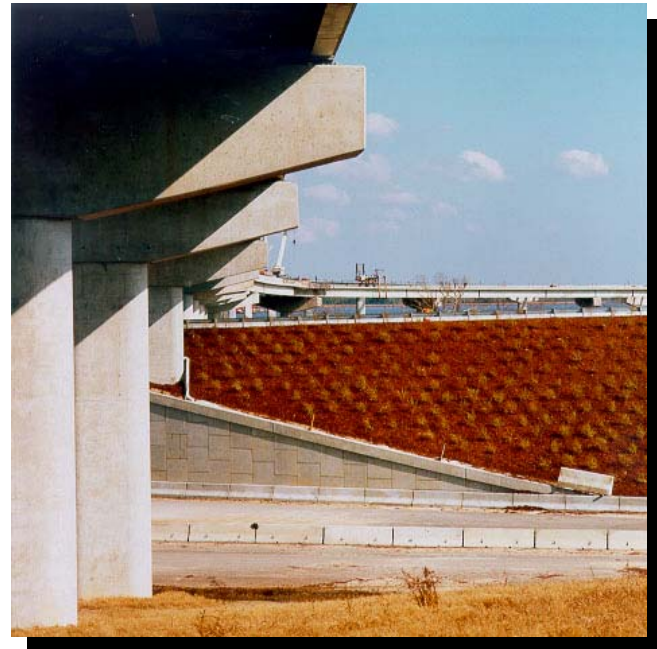
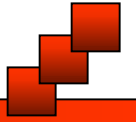
**Developing a Rating Program for North Carolina**

# Pavement Condition Survey





# Bridge Condition Survey





# Maintenance Condition Survey



## Bridge

- ✓ Decks
- ✓ Rails
- ✓ Expansion Joints
- ✓ Superstructure
- ✓ Substructure

## Pavement

- ✓ Flexible
- ✓ Rigid

## Roadway

- ✓ Low Shoulder
- ✓ High Shoulder
- ✓ Lateral Ditches
- ✓ Lateral Ditch  
Erosion

## Roadside

- ✓ Mowing
- ✓ Brush and Tree  
Control
- ✓ Litter & Debris
- ✓ Slope
- ✓ Guardrail

## Drainage

- ✓ Crossline Pipe
- ✓ Driveway Pipe
- ✓ Curb & Gutter
- ✓ Catch Basin &  
Drop Inlets
- ✓ Other Drainage  
Features

## Environmental

- ✓ Turf Condition
- ✓ Miscellaneous  
Vegetation  
Management

## Traffic Control Devices

- ✓ Traffic Signs
- ✓ Pavement Striping
- ✓ Words and Symbols
- ✓ Pavement Markers

# Roadway Items (Shoulders and Ditches)



<b>Element</b>	<b>Feature</b>	<b>Threshold Condition</b>
<b>Roadway pavement</b>	Flexible Pavement Rigid Pavement	<i>NCDOT Pavement Condition Survey</i> <i>NCDOT Rigid Pavement Rating System</i>
<b>Unpaved Shoulders &amp; Ditches</b>	<b>Low Shoulder</b> <b>High Shoulder</b> <b>Lateral Ditches</b> <b>Lateral Ditch Erosion</b>	<b>Low <math>\geq</math> 2 inches</b> <b>High <math>\geq</math> 1 inch</b> <b>Blocked <math>&gt;</math> 50% and Not Functioning as designed</b> <b>Eroded <math>\geq</math> 1 ft</b>
<b>Drainage</b>	Crossline Pipe Driveway Pipe Curb & Gutter Catch Basin & Drop Inlet Other Drainage Features	Blocked $\geq$ 50%, or Damaged Blocked $\geq$ 50%, or Damaged Blocked $\geq$ 2 in x 2 ft, or Damaged Blocked $\geq$ 25%, Damaged, or Grate Problem Not Functioning as designed
<b>Roadside</b>	Mowing Brush and Tree Control Litter & Debris Slope Guardrail	Average Grass Height Within 15' above, 10' back of ditch/shoulder Number of Pieces $\geq$ Fist-Sized Failures $\geq$ 1ft wide Damaged, or Not Functioning as designed
<b>Traffic Control Devices</b>	Traffic Signs Pavement Striping Words and Symbols Pavement Markers	Illegible, Missing, or Obliterated Worn, Missing, or Obliterated Damaged or Missing Worn, Missing, or Obliterated
<b>Environmental</b>	Turf Condition Misc. Vegetation Management	Bare, Dead, Diseased, Distressed, or Weedy Uncontrolled Growth at Signs or Guardrail

Table 1 – Maintenance Elements Features and Threshold Conditions



**1" drop-off**





**2" drop-off**

# Drainage

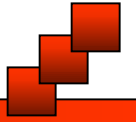




<b>Element</b>	<b>Feature</b>	<b>Threshold Condition</b>
<b>Roadway pavement</b>	Flexible Pavement Rigid Pavement	<i>NCDOT Pavement Condition Survey</i> <i>NCDOT Rigid Pavement Rating System</i>
<b>Unpaved Shoulders &amp; Ditches</b>	Low Shoulder High Shoulder Lateral Ditches Lateral Ditch Erosion	Low $\geq 2$ inches High $\geq 1$ inch Blocked $\geq 50\%$ and Not Functioning as designed Eroded $\geq 1$ ft
<b>Drainage</b>	<b>Crossline Pipe</b> <b>Driveway Pipe</b> <b>Curb &amp; Gutter</b> <b>Catch Basin &amp; Drop Inlet</b> <b>Other Drainage Features</b>	<b>Blocked <math>\geq 50\%</math>, or Damaged</b> <b>Blocked <math>\geq 50\%</math>, or Damaged</b> <b>Blocked <math>\geq 2</math> in x 2 ft, or Damaged</b> <b>Blocked <math>\geq 25\%</math>, Damaged, or Grate Problem</b> <b>Not Functioning as designed</b>
<b>Roadside</b>	Mowing Brush and Tree Control Litter & Debris Slope Guardrail	Average Grass Height Within 15' above, 10' back of ditch/shoulder Number of Pieces $\geq$ Fist-Sized Failures $\geq 1$ ft wide Damaged, or Not Functioning as designed
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Table 1 – Maintenance Elements Features and Threshold Conditions

# Roadside



<b>Element</b>	<b>Feature</b>	<b>Threshold Condition</b>
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<b>Roadside</b>	<b>Mowing</b> <b>Brush and Tree Control</b> <b>Litter &amp; Debris</b> <b>Slope</b> <b>Guardrail</b>	<b>Average Grass Height</b> <b>Within 15' above, 10' back of ditch/shoulder</b> <b>Number of Pieces <math>\geq</math> Fist-Sized</b> <b>Failures <math>\geq 1</math>ft wide</b> <b>Damaged, or Not Functioning as designed</b>
<b>Traffic Control Devices</b>	Traffic Signs Pavement Striping Words and Symbols Pavement Markers	Illegible, Missing, or Obliterated Worn, Missing, or Obliterated Damaged or Missing Worn, Missing, or Obliterated
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Table 1 – Maintenance Elements Features and Threshold Conditions

# Traffic Control Devices

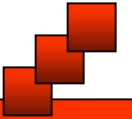


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<b>Traffic Control Devices</b>	<b>Traffic Signs</b> <b>Pavement Striping</b> <b>Words and Symbols</b> <b>Pavement Markers</b>	<b>Illegible, Missing, or Obliterated</b> <b>Worn, Missing, or Obliterated</b> <b>Damaged or Missing</b> <b>Worn, Missing, or Obliterated</b>
<b>Environmental</b>	Turf Condition Misc. Vegetation Management	Bare, Dead, Diseased, Distressed, or Weedy Uncontrolled Growth at Signs or Guardrail

Table 1 – Maintenance Elements Features and Threshold Conditions



# Environmental





<b>Element</b>	<b>Feature</b>	<b>Threshold Condition</b>
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<b>Environmental</b>	<b>Turf Condition</b> <b>Misc. Vegetation Mgm't.</b>	<b>Bare, Dead, Diseased, Distressed, or Weedy</b> <b>Uncontrolled Growth at Signs or Guardrail</b>

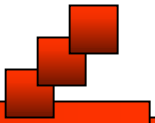
Table 1 – Maintenance Elements Features and Threshold Conditions

# Large System / Large Sample Size

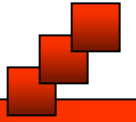
(95% confidence level,  $\pm 6\%$ )

System	Mileage	Number of Samples	Level of Survey
Interstate	763	<b>250</b>	<b>Statewide</b>
Primary	11,081	<b>3500</b>	<b>Division</b>
Urban	7,607	<b>3500</b>	<b>Division</b>
Secondary	53,507	<b>3500</b>	<b>Division</b>
<b>Total Sample Size</b>		<b>10,750</b>	

# 2002 Survey Findings



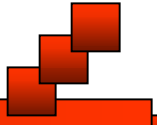
# Survey Findings - Primary



**Pavements**

**PCR = 83.5**

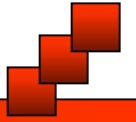
# Survey Findings - Primary



**Shoulders & Ditches**  
**Blocked ditches = 6%**



# Survey Findings - Primary

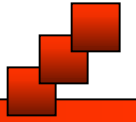


**Drainage**

**Other Features = 14%**

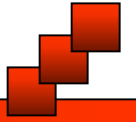


# Survey Findings - Primary



**Roadside  
Guardrail = 4%**

# Survey Findings - Primary

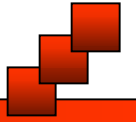


## **Traffic Control**

**Pvm't Markers = 52%**

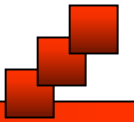
**Pvm't Markings = 12%**

# Survey Findings - Primary



**Environmental  
Misc. Vegt. Mgmt = 13%**

# What does that mean?







***Level of Service “A”  
(Best)***



***Level of Service “B”  
(Good)***





***Level of Service “C”  
(Fair)***



***Level of Service “D”  
(Poor)***



***Level of Service “F”  
(Worst)***

# Maintenance Performance Measures - Primary

ELEMENT 1			Service Level					Acceptable Level of Service
Roadway Pavement			A	B	C	D	F	
Activities	Condition Indicators	Performance Measures	Threshold	Threshold	Threshold	Threshold	Threshold	
Pavement Maintenance	Pavement Condition Rating	PCR	98	93	86	70	< 70	C

ELEMENT 2			Service Level					Acceptable Level of Service
Unpaved Shoulders and Ditches			A	B	C	D	F	
		Performance						
<b>Low Shoulder</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>F</b>			
	<b>≤ 1%</b>	<b>≤ 5%</b>	<b>≤ 8%</b>	<b>≤ 11%</b>	<b>&gt; 11%</b>			

ELEMENT 3			Service Level					Acceptable Level of Service
Drainage			A	B	C	D	F	
Activities	Condition Indicators	Performance Measures	Threshold	Threshold	Threshold	Threshold	Threshold	
Crossline Pipe	Blocked ≥ 50%, or Damaged	EA	2%	7%	11%	15%	> 15%	C
Driveway Pipe	Blocked ≥ 50%, or Damaged	EA	10%	15%	25%	35%	> 35%	C
Curb & Gutter	Blocked ≥ 2 in x 2 ft, or Damaged	FT	2%	5%	7%	11%	> 11%	C
Catch Basin & Drop Inlet	Blocked ≥ 25%, Damaged, or Grate Problem	EA	2%	5%	8%	12%	> 12%	C
Other Drainage Features	Not Functioning as designed	EA	2%	6%	9%	12%	> 12%	C



## Statewide Average - Primary System

Maintenance Activity	Level of Service									
	+ A -		+ B -		+ C -		+ D -		+ F -	
<b>Pavement</b>										
Pavement							■			
<b>Unpaved Shoulders and Ditches</b>										
Low Shoulder									■	
High Shoulder									■	
Lateral Ditches			■							
Lateral Ditch Erosion	■									
<b>Drainage</b>										
Crossline Pipe										■
Driveway Pipe										■
Curb & Gutter					■					
Catch Basin & Drop Inlet										■
Other Drainage Features										■
<b>Roadside</b>										
Mowing			■							
Brush & Tree Control							■			
Litter & Debris					■					
Slope			■							
Guardrail					■					
<b>Traffic Control Devices</b>										
Traffic Signs								■		
Pavement Striping									■	
Words & Symbols									■	
Pavement Markers										■
<b>Environmental</b>										
Turf Condition							■			
Misc. Vegetation Management					■					

# Putting the Information in Context

A decorative graphic consisting of three overlapping orange squares arranged in a small cluster to the right of the title.

# **Since the Highway Trust Fund was enacted:**

**1989**

- **76,808 road miles**
- **127,809 paved lane miles**
- **16,104 miles of unpaved roads**
- **16,900 structures**
- **61.1 M sf bridge deck area**

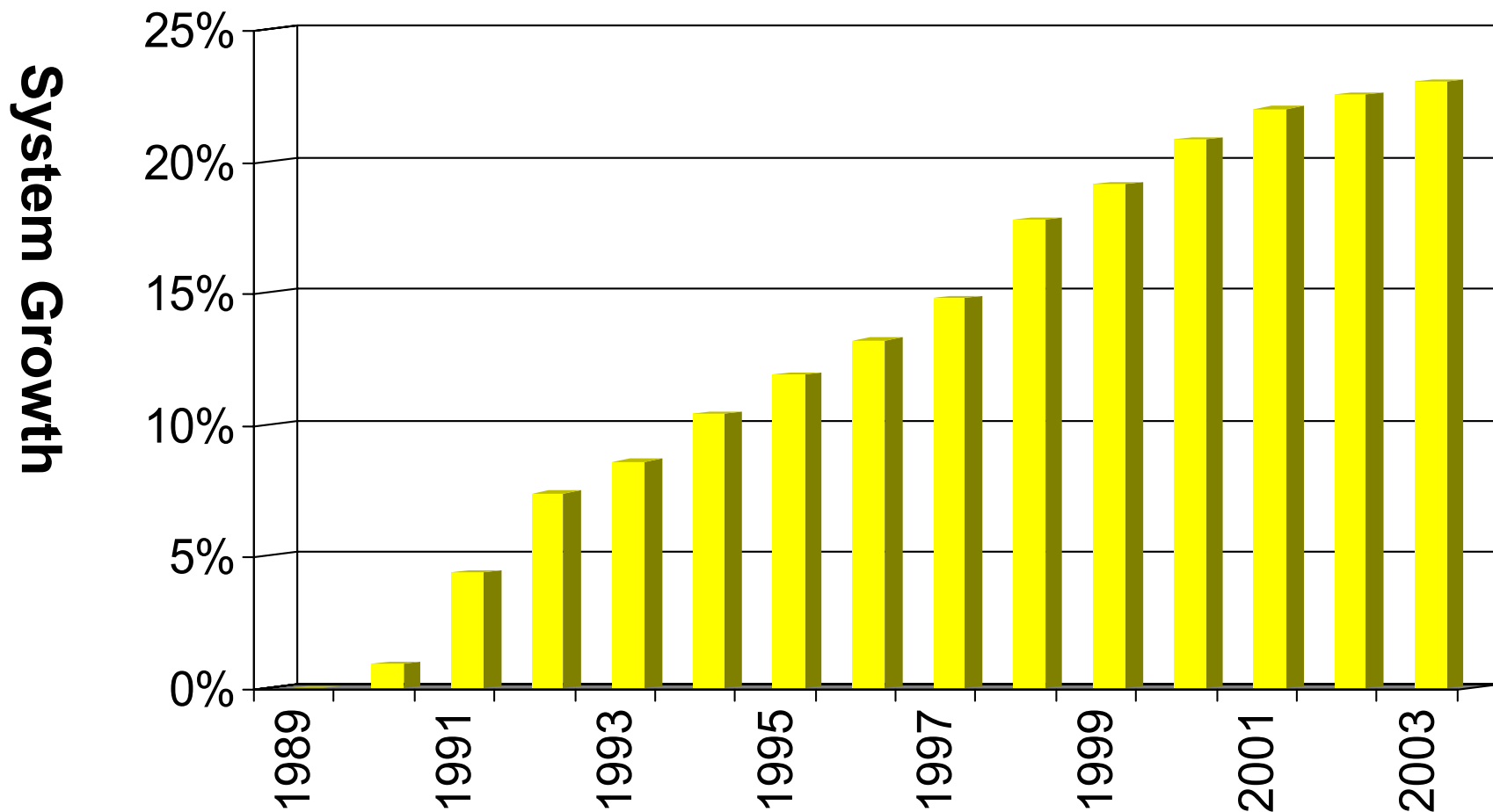
**2003**

- **78,347 road miles**
- **155,960 paved lane miles**
- **6,644 miles of unpaved roads**
- **17,463 structures**
- **72.3 M sf bridge deck area**

## **North Carolina State Highway System**

# Highway System Growth

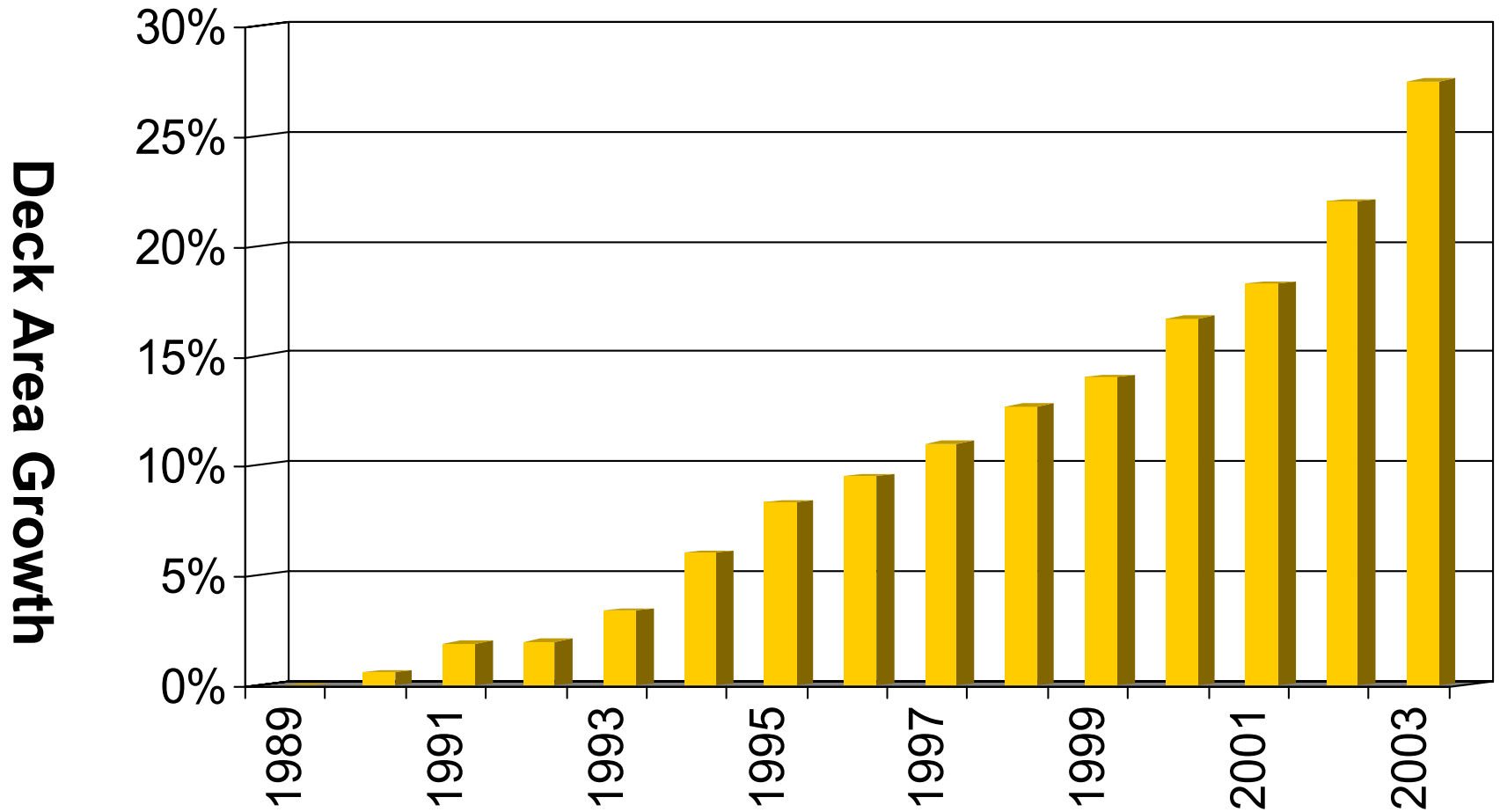
(Paved Lane Miles)





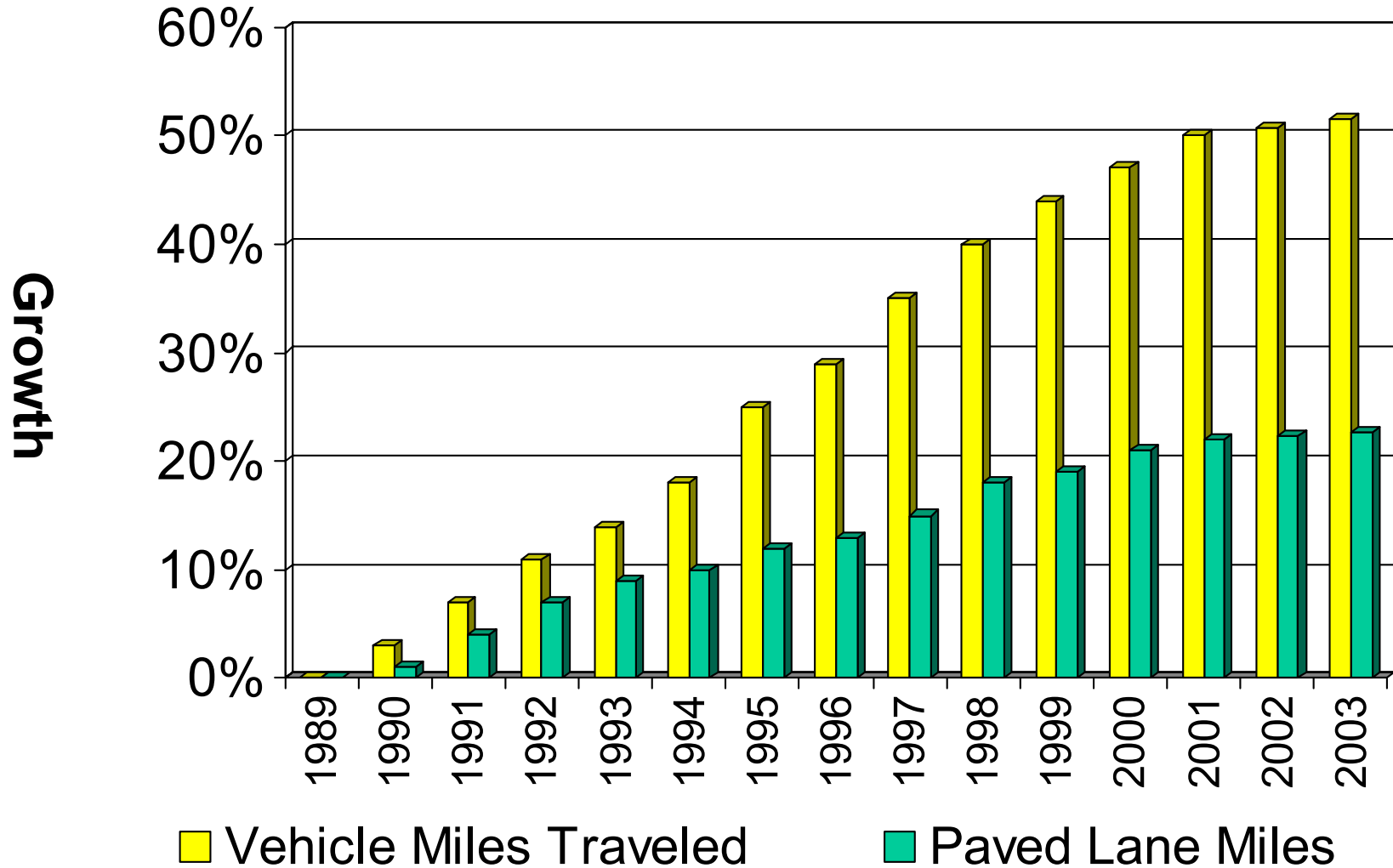
# Bridge System Growth

(Square Feet of Bridge Deck)

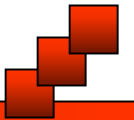


# Highway System Usage

(Vehicle Miles Traveled)



# Reporting Back to the Customers



# **North Carolina Department of Transportation**

## **Condition Assessment & Funding Needs for North Carolina's Highway System**



## **Report to the Joint Legislative Transportation Oversight Committee**

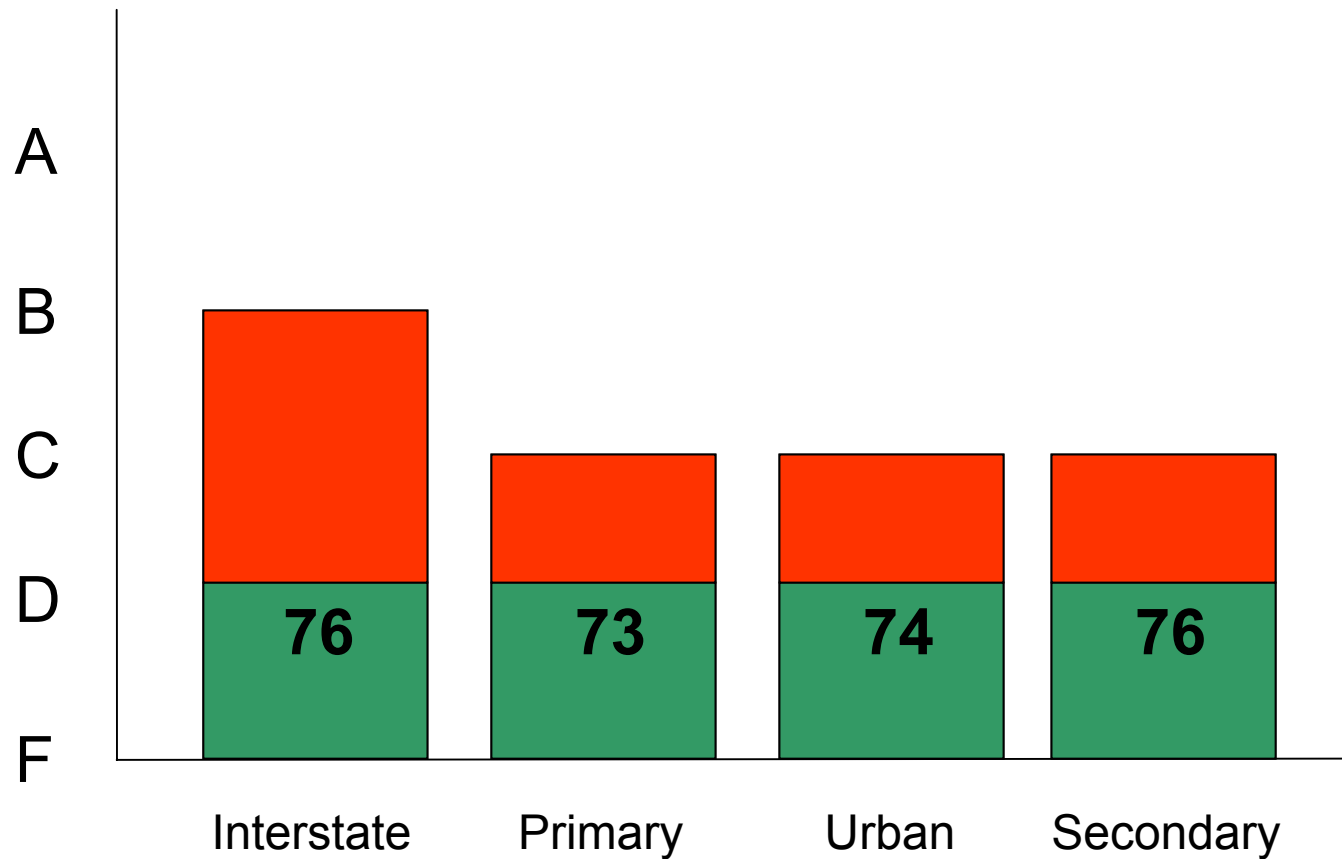
**January 14, 2003**

**Steve Varnedoe**

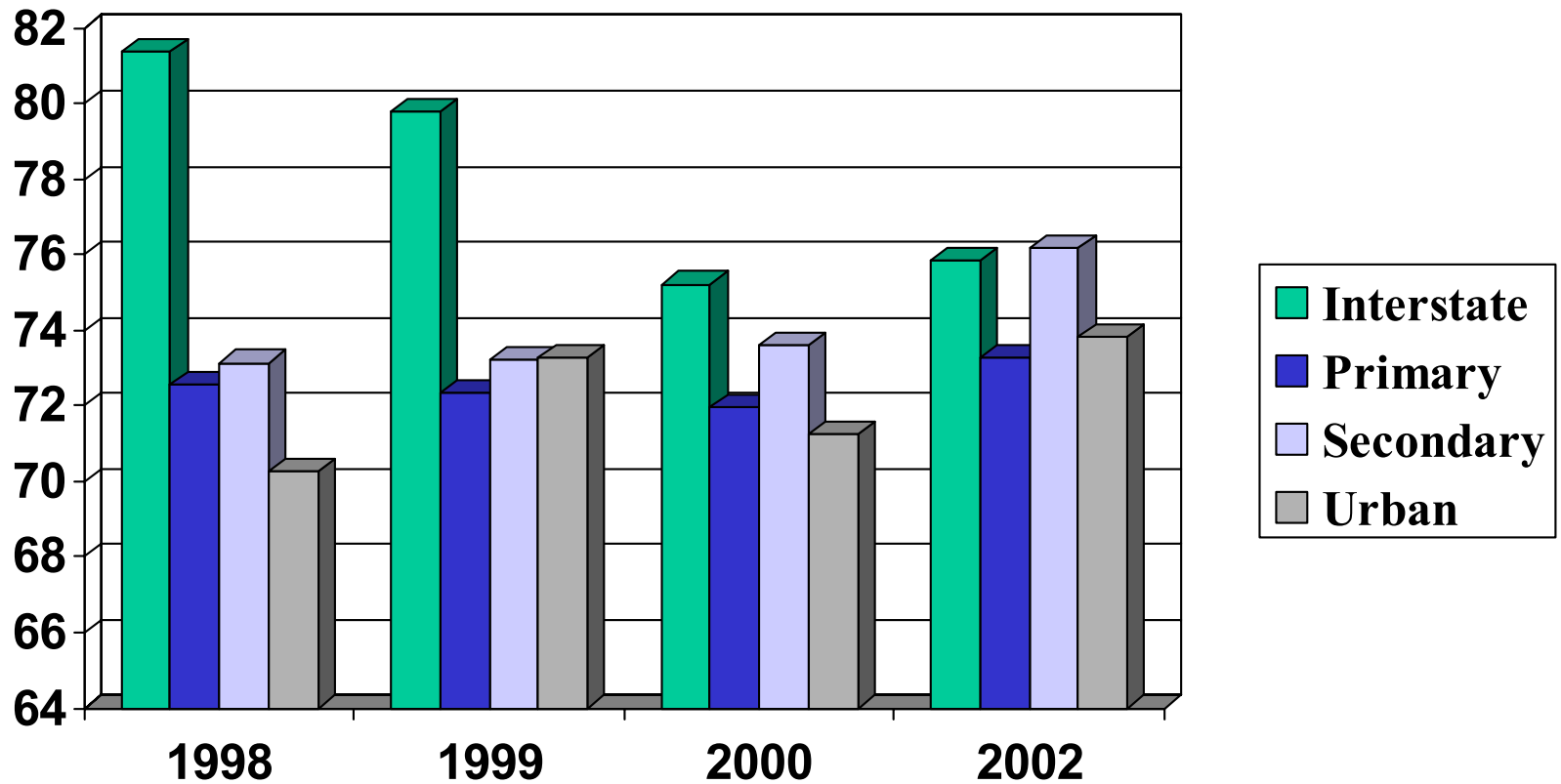


# Roadway Level of Service

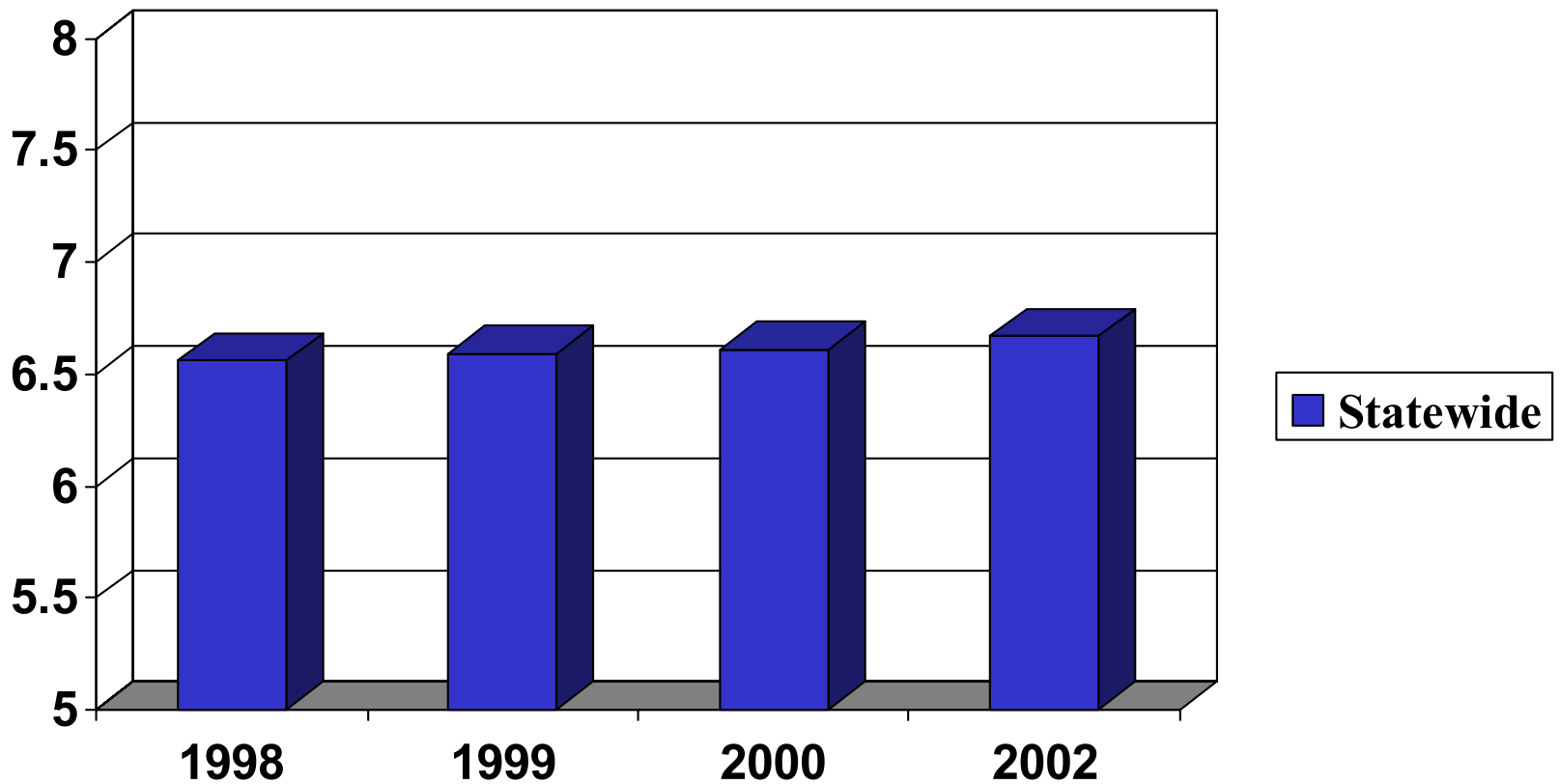
(2002 Survey)



# Performance Measure Trends (Roadway)

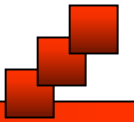


# Performance Measure Trends (Bridge)

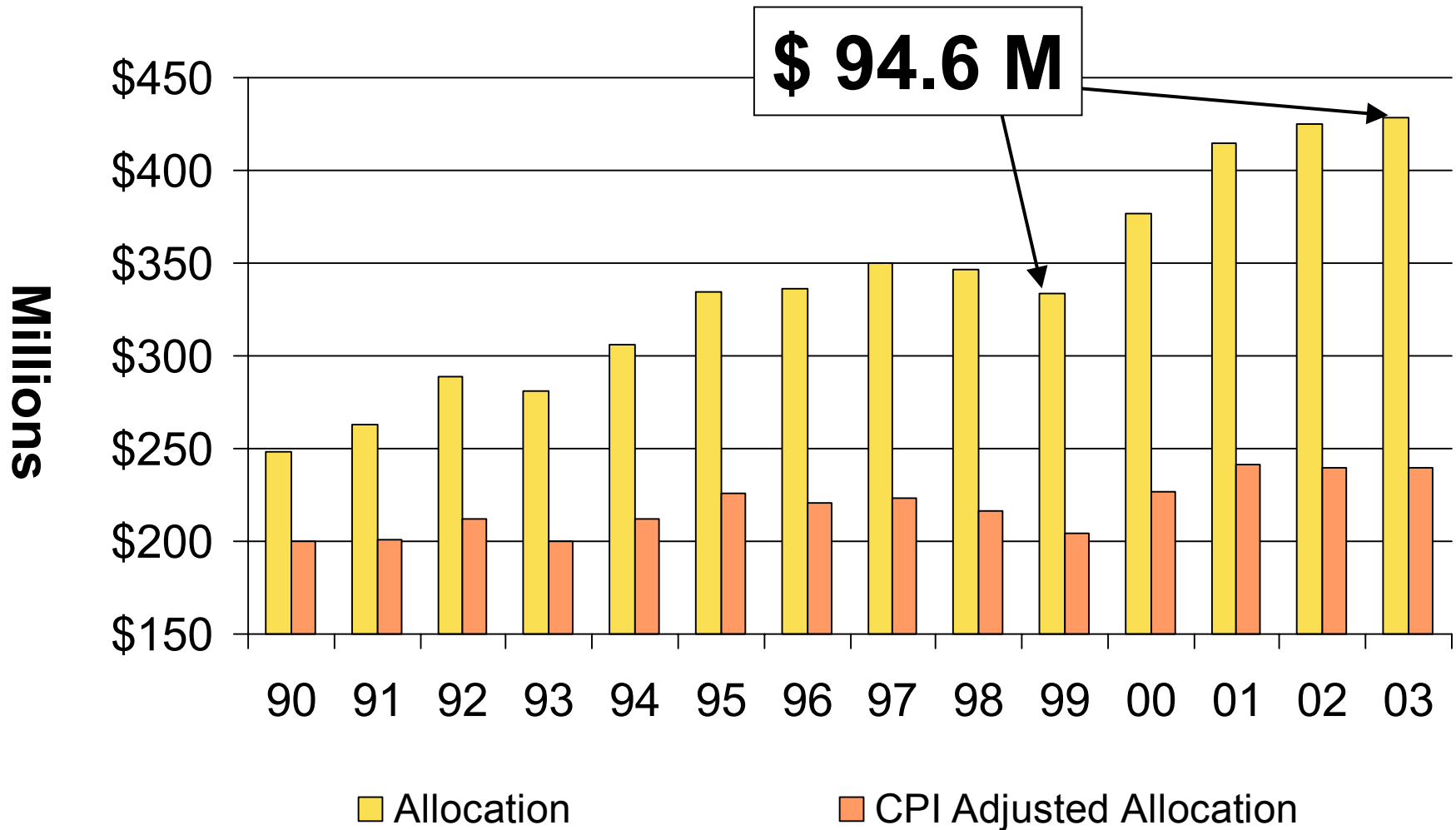


**Target = 7**

# Results

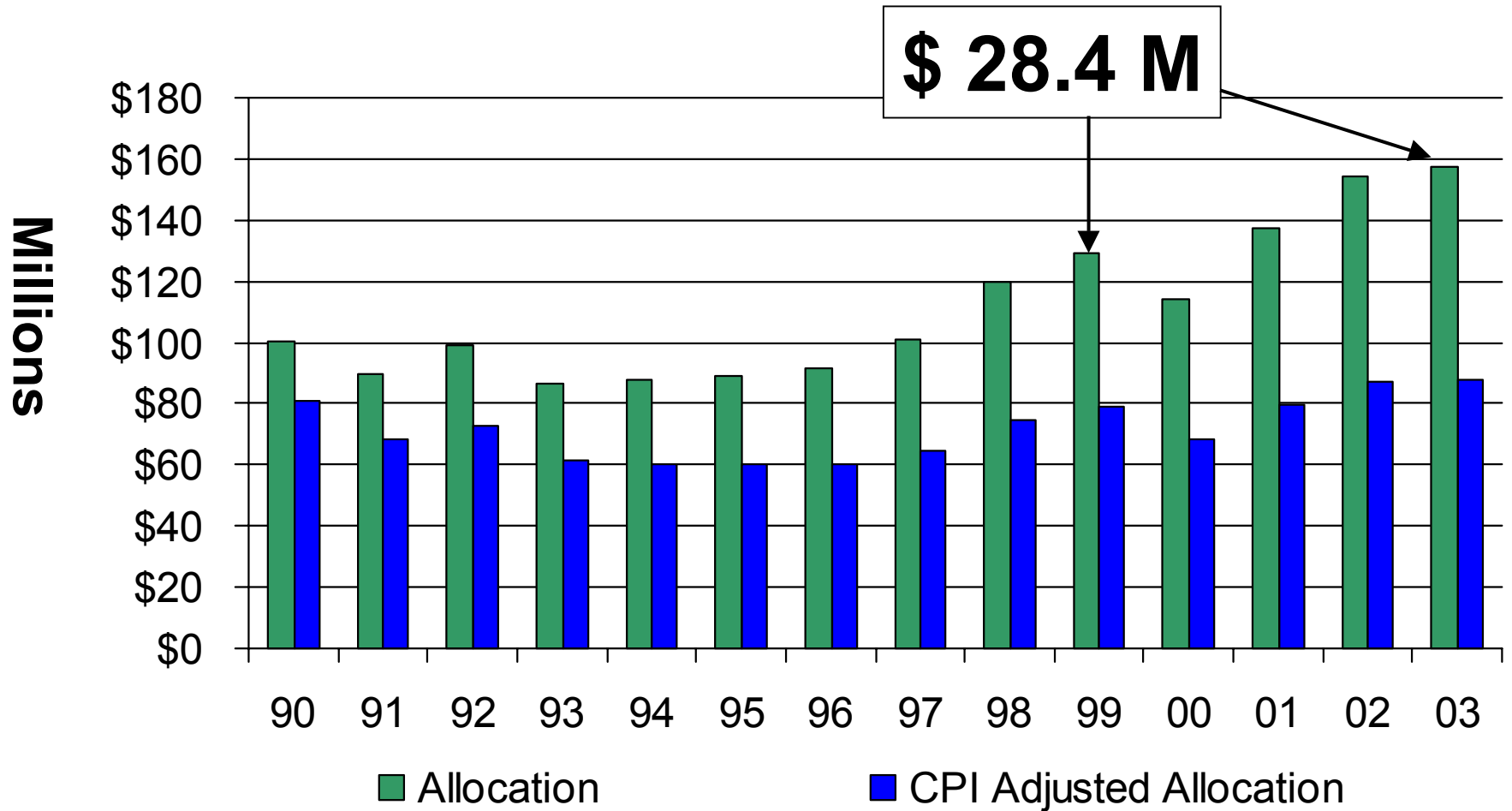


# History of Routine Maintenance Funding





# History of Resurfacing Funding

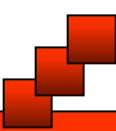


# Supplemental Maintenance Funds (Annual Basis)

A decorative graphic consisting of four orange squares arranged in a staircase pattern, located in the top right corner of the slide.

- TIP Funding
- Senate Bill 1005
- NC Moving Ahead

# Supplemental Maintenance Funds (Annual Basis)



- TIP Funding
  - Traffic System Operations - \$ 13.0 million
  - Positive Guidance Program - \$ 6.6 million
  - ITS Traffic Operations - \$ 13.5 million
  - Bridge Preservation Funds - \$ 2.0 million

# R-4701 + Maintenance Funds

## Traffic Systems Operations Program



- **Two funding sources - one charging scheme**

Year 3: Total of \$18.5 million

\$5.5 million from Flexible “M” Funds

\$13.0 million from TIP R-4701

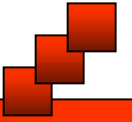
### **For operation and maintenance of traffic management devices**

(signal equipment, LED's, Preventive Maintenance, Testing, Training, and ITS Devices)

- **Allocation based on number of signals owned by DOT  
(including schedule C and schedule D agreements)**
- **Funds are managed centrally**
- **Report mechanism for Federal Audit**

# R-4067

## Positive Guidance Program



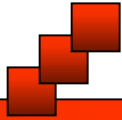
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- \$6.6 million per year
- Used for improving guidance and visibility on the primary roadway system
- Division's needs and priorities identified on an annual basis
- Chief Engineer's Office determines allocations with statewide consideration
- Report mechanism for Federal Audit



# R-4049

## Traffic Operations

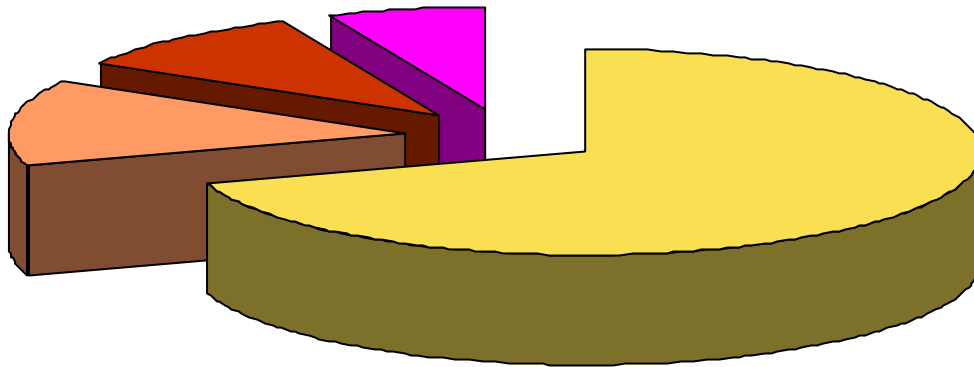






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- \$13.5 million
- Used for operation and maintenance of Incident Management and ITS Operations program
- Division's needs and priorities identified (by Divisions) on an annual basis (by Federal Fiscal Year)
- ITS Operations Unit determines allocations with statewide consideration
- Report mechanism for Federal audit

# Estimated Total Funding this Fiscal Year

In millions



	<b>Maint.</b>	<b>\$45.5</b>
	<b>R-4701</b>	<b>\$13.0</b>
	<b>R-4067</b>	<b>\$ 6.6</b>
	<b>R-4049</b>	<b>\$13.5</b>

**\$78.6 million!!!**

# Supplemental Maintenance Funds (Annual Basis)



- TIP Funding
- Senate Bill 1005
  - Traffic Mgmt. System Improvements - \$ 15 million
  - Primary Pavement Preservation - \$ 135 million

# Impact of SB 1005 on Pavement Needs

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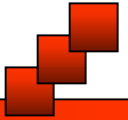
- Targets major primary system corridors
- Approx. 5,500 lane miles will be strengthened and resurfaced
- Helps eliminate resurfacing backlog
- Reduces pavement needs

# Supplemental Maintenance Funds (Annual Basis)



- TIP Funding
- Senate Bill 1005
- NC Moving Ahead
  - \$630 million for FY 2003-05 for highways
  - \$360 million for FY 2004-05

# NC Moving Ahead

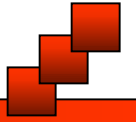


Funds used for preservation, modernization projects

- Safety enhancement
- Reduce congestion
- Improve traffic flow
- Reduce accidents
- Upgrade pavement widths and shoulder
- Extend pavement life
- Improve pavement smoothness
- Rehabilitate or replace deficient bridges



# What's next?



- Connect condition data with MMS
- Implement new PMS
- New BMS
- Integrate Traffic Signal Management System
- Integrate real time GPS data

